MOA/HEC RAS Checklist

Developed from Common Issues

It should be noted that this list is not a definitive list of all that is reviewed during an MOA review. It is provided as a guide to ensure consistency and quality.

The following checked items have been reviewed and incorporated into the models as appropriate.
[PROJECT TIP # or ID: _____]

Signature: _____

☐ 1. **Model Version:**   The HEC-RAS version used shall be one currently accepted by FEMA* and shall be at least as new as the effective model version. It is preferred that MOA submittal models be run in the latest accepted version of HEC-RAS; however, if the effective model was run in an earlier version, it is acceptable to use the older version for all of the MOA models (duplicate, corrected, and revised), and this should be documented in the narrative.   If the duplicate effective model can be run in the latest version of HEC-RAS with the result that computed water surface elevations match those in the effective FIS within the acceptable tolerance (0.5 ft. with no negative surcharge), then using the latest accepted version of HEC-RAS is preferred.

* Currently accepted HEC-RAS versions can be found at:
 https://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping/hydraulic-numerical-models-meeting-minimum
 Legacy models of HEC-RAS can be downloaded at:
 http://www.hec.usace.army.mil/software/hec-ras/downloads.aspx

☐ 2. Confirm if **hydrology** in the effective model matches the FIS or not. If not, it should be noted in the project narrative. Use the flows which produce the effective water surface elevations. Flows should not change in any of the submitted models.

☐ 3. **Boundary Conditions:** If you are using a truncated model, then you should use a known starting water surface elevation the majority of the time and tie-in to within 0.5 ft. of the effective model at the upstream cross section in the model. (Show the Effective WSEL in the comparison table at tie points for review purposes.) Otherwise, if the model is not truncated, the boundary conditions should not vary from the effective model (anything may be possible, but there should be overwhelming evidence that the boundary condition is incorrect before it is revised from the effective model, and even then, it will only be done in the corrected effective and additional models).   The Corrected and Revised Models should be extended until their water surface elevations and stream velocities match exactly. The top width should also match within a foot. The only exception to this would be if the effective model ends before the models are able to match.

☐ 4. Do not use **fixed water surface elevation** points at any locations in your models. The only exception to this would be use of "fixed" starting water surface elevation as boundary condition at most downstream section of a truncated duplicate effective model. FMP

typically requests inclusion of a copy of the unedited full effective model for reference.

☐ 5. **Watch for datum adjustments.** For models with a different datum, make sure that boundary conditions are adjusted along with geometry. Make sure <u>all</u> plans (Corrected Effective and Revised) are adjusted.

☐ 6. **Geo-Referencing:** For any effective model which has been geo-referenced, geo-reference all new cross sections which have been added to the models.

☐ 7. **New Cross Sections:** Interpolating cross sections is not allowed. If new cross sections are added, they should be field-surveyed, or LIDAR data may be used in areas beyond the reach of the normal surveyed area. For cross sections generated from LIDAR, the channel geometry may be interpolated or estimated. The cut line length in the geometric data needs to match the cross section length.

☐ 8. **Center reach lengths** should be the upstream station minus the downstream station. When these do not line up, it is noticed. Sometimes it is commented on and sometimes not depending on the effective model. Either way, attention should be paid to reach lengths during the model build, especially when adding in new cross sections, adjusting effective cross section locations or modifying the reach due to stream relocation.

☐ 9. Make sure your **bank stations are containing your stream** centerline in the geometric window from HEC-RAS.

☐ 10. **Corrected Model:** The Corrected model should be used to correct errors and omissions discovered in the Effective model. It should not be used to correct an entire reach. Therefore, corrections should be made in the area of influence of the project, which is typically between sections 1 and 4. All corrections should be noted in the project narrative.

☐ 11. **Bridge modeling methods:** Set Max Submergence to 0.98 unless the engineer considers another number more appropriate. For low flow on the crossing in question, run "Momentum" as well as "Energy" for low flow and check "Use Highest Energy Answer." If the engineer deems it appropriate, Yarnell can be checked as well, though it is generally not required. The "Add friction component" for momentum should be checked, but the "Add weight component" should not. For high flow on the crossing in question, check "Pressure and/or Weir" and set the Submerged Inlet + Outlet Cd. If the effective model does not include these modeling methods, they should be included in the Corrected and Revised Conditions models. For all other crossings in the model, do not change the modeling methodology unless the engineer determines that it is appropriate to do so. All changes in modeling should be described in the project narrative.

☐ 12. **Manning's "n" changes** should be justifiable and stated in the project narrative. They should be supported with photographs. Manning's "n" changes without documentation will not be accepted under the MOA.

☐ 13. **Contraction and expansion coefficients** should typically be 0.3 and 0.5 respectively for sections 4, 3, and 2 in the flow contraction and expansion reach associated with bridge and culvert structures. Contraction and expansion coefficients should be 0.1 and 0.3 in all other locations. If the effective model has other contraction and expansion coefficients and is older than 1998, the coefficients should be changed in the Corrected and Revised models to 0.1 and 0.3 unless the engineer deems it appropriate otherwise. Contraction and expansion coefficients should be discussed in the model narrative, and any changes from the effective model or use of non-typical values should be justified. Note Item 22 below regarding keeping any changes within the reach affected by the project – There is no need to correct the entire reach of the model outside of the influence of the project.

☐ 14. **Encroachment station placement** should tie-in with the effective model stations at the upstream and downstream cross section in any truncated model. Other than that, all floodway encroachment stations should be placed in appropriate locations. They should be contained by the 100-yr floodplain boundary, be outside of bank stations and not be placed in the ineffective flow areas, etc. Always use Method 1 to set encroachment stations in the Duplicate Effective, Corrected, and Revised models. If other methods used in the effective model, change to Method 1, and insert the exact encroachment stations from the Effective model output into Duplicate Effective model. See below
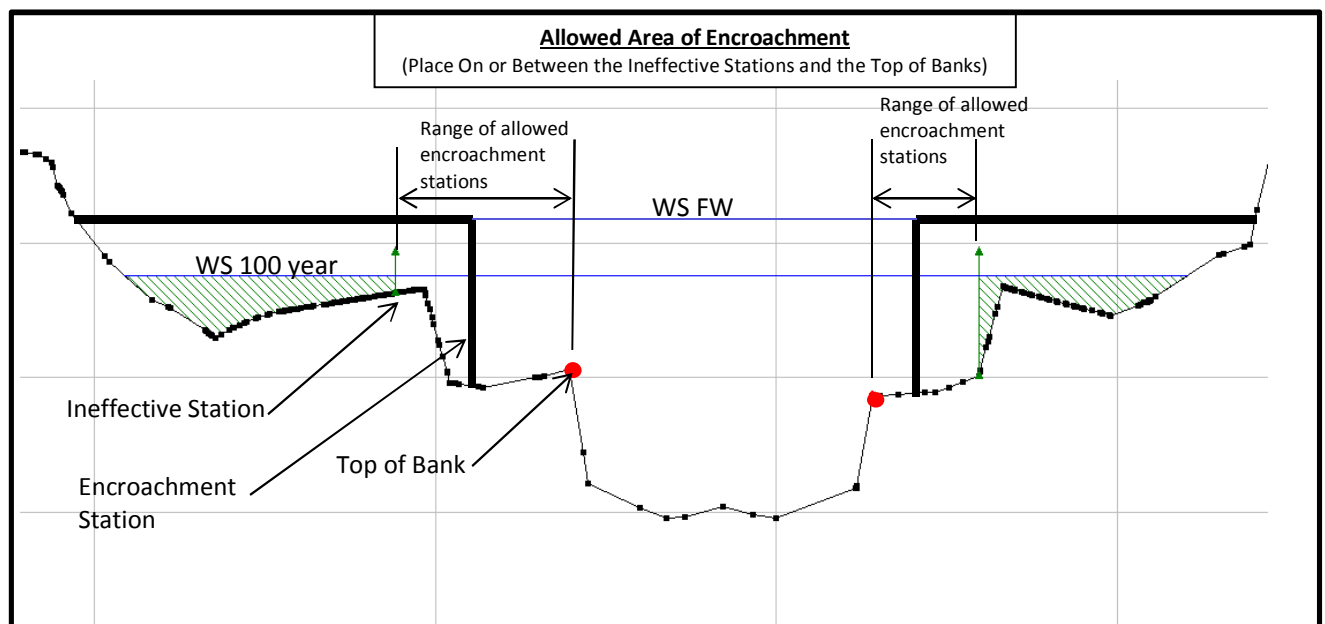
☐ 15. **Ineffective areas**: Make sure up and down stream areas act together on either side of bridge (both are either effective or ineffective). Do not adjust ineffective flow areas anywhere else in the model unless the engineer deems it appropriate, and then it should be adjusted in both the Corrected and Revised models. Describe the placement and/or adjustment of ineffective flow areas in the project narrative. The general accepted contraction ratio (CR:1) is 1:1 and the expansion ratio (ER:1) generally ranges from 1:1 to 4:1. Also, when revising ineffective flow elevations be consistent and make sure that the ineffective flow areas act together on the upstream and downstream cross sections of a structure (sections 2 and 3).
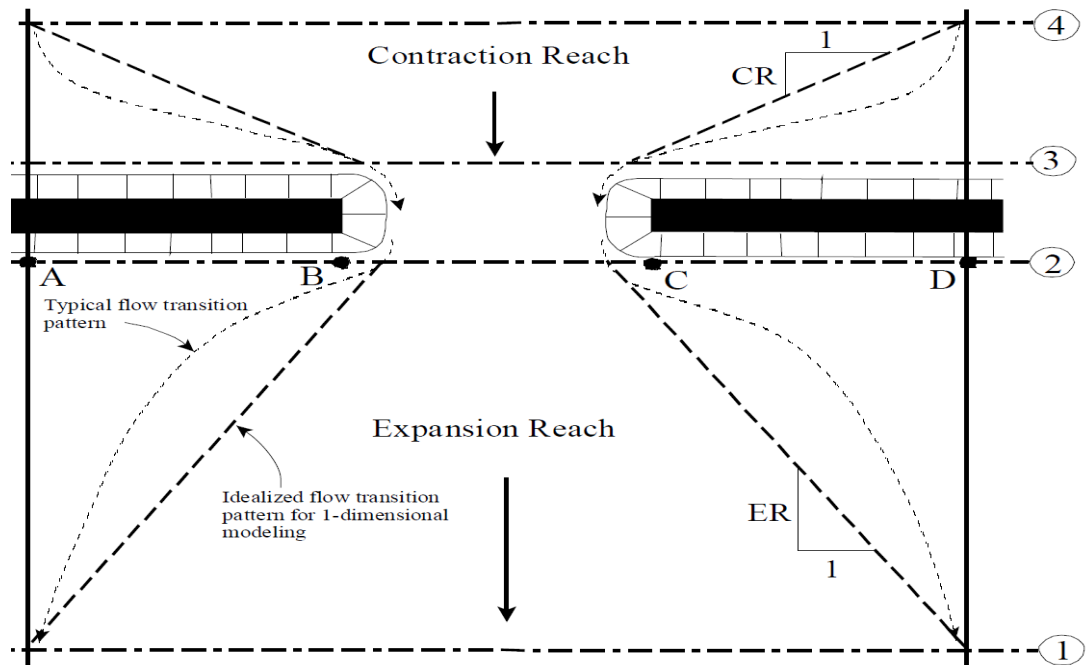
☐ 16. **The Structure Data (deck width, low chord, roadway grade, culvert inverts, etc.)** in the hydraulic model should match the data contained in the structure reports (BSR & CSR). Any datum adjustments between the structure reports and hydraulic model should be accounted for and noted in the narrative. The following information needs to be included in the narrative:

  ☐ Note the height of the bridge rail modeled in both the Corrected Effective and Revised models.

  ☐ Note that the road profile shown in both the Corrected Effective and Revise models reflects the highest roadway elevations.

  ☐ Note that the low chord elevation of the bridge shown in the Corrected Effective and Revised models reflects the lowest low chord elevation of the bridge and has been adjusted for super elevation drop and asphalt/concrete overlay on the bridge.

  ☐ Note if the bridge length and or opening has been adjusted for skew in both the Corrected Effective and Revised models. Describe the skew adjustment mathematically and/or graphically.

  ☐ Note if the bridge opening has been adjusted due to the abutment and or cap width in both the Corrected Effective and Revised models.

  ☐ Note the pier width and shape used in both the Corrected Effective and Revised models.

☐ 17. **Floodway or Encroachment Surcharges:** Make sure they are no greater than one foot nor negative in the Corrected Effective or Revised Models. Negative surcharges are usually due to modeling error or over-encroachment around bridges and culverts.

☐ 18. **Revised – Corrected Effective WSEL's**; Revised WSEL's should be equal to or lower than Corrected WSEL's for MOA's (unless Type 2d or 2e).

☐ 19. **Levees** should not be used without prior approval unless it is a certified levee, as other techniques exist to block effective flow in the HEC-RAS environment.

☐ 20. **For project in a redelineated detailed study reach, include effective model data files (input and output; e.g. HEC-2)** as part of the MOA package. In the event that an effective model for a **Redelineated Detailed Study** was not available, include documentation to verify that an **external data request (EDR)** was submitted through FMP to FEMA NFIP Library with the result that no copy of the effective model could be found, thus verifying that "due diligence" was exercised in attempting to obtain the effective model. Also, for Type 2c, provide documentation in model narrative of consultation/concurrence by FMP that Type 2c submittal is acceptable.

☐ 21. **HEC-2:** HEC-2 may be used for the duplicate, corrected and revised models if the Effective model is also HEC-2; however, it is preferred that the Effective HEC-2 model be imported/converted to HEC-RAS. Care should be taken when converting HEC-2 data to HEC-RAS. The HEC-RAS model will likely require adjustments and corrections in order to match the effective results. The Duplicate Effective (imported) HEC-2 results should match the Effective HEC-2 results. If the model is converted from HEC-2 to HEC-RAS, the Duplicate Effective model must be in HEC-RAS. The Duplicate Effective software needs to match the Corrected and Revised model software.

☐ 22. **Type 2c Six (6) Section Analysis:** This does **NOT** include the two internal structure cross sections. In addition to the four cross sections required to correctly model a bridge or culvert (as defined in Figure 5-1 of the HEC-RAS Hydraulic Reference Manual) there must be a **minimum** of two additional cross sections, at least one upstream of the approach cross section and one downstream of the exit cross section. If starting with Manning's Normal Depth as the downstream boundary condition of a subcritical hydraulic water surface profile computation model, the location of the downstream boundary cross section should be far enough downstream of the study reach to allow the computed water surface profile to converge to a consistent answer by the time the computations reach the exit cross section, so as not to introduce errors within the study reach. Additional sections may be needed depending on site-specific hydraulic controls and constraints upstream and downstream of the study reach. Only the BFE natural profile will be reviewed. No floodway profile is required.

☐ 23. **Model Submittal to FMP:** Only submit the required runs; e.g., Duplicate Effective, Corrected Effective and Revised. Only submit the same flow profiles as used in the Effective model (including future conditions, if effective for study reach). If additional design frequencies are needed then create a separate design model, but do not submit to FMP. Make sure all runs have an output file saved.

☐ 24. **Summary:** The summary comparison table (Excel) should include, at a minimum, the following information:

- Duplicate Effective, Corrected, and Revised results;
- Water surface elevations for the 1% and the floodway (encroachment) models and the difference between water surface elevations from the Corrected model to the Revised model;
- Encroachment stations and any changes in encroachment stations from the Effective model to the Revised model
- Highlight maximum increase or decrease in base flood elevation.

☐ 25. **Upstream and Downstream Limits:** The reported upstream and downstream limits should extend just beyond the range of published FEMA FIS cross sections for which there is a water surface elevation difference between the corrected and revised plans (i.e. the affected reach).